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THE ALBERTA OIL SANDS STORY

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AN ALBERTA OIL SANDS STATUS REPORT

THE GOVERNMENT OF THE PROVINCE OF ALBERTA

FOREWORD

During the past year there has been a new interest among Canadians as to the future role of Alberta's oil sands as a source of oil to meet increasing energy requirements within our nation. This is understandable since estimated recoverable oil from these deposits represents one of the largest potential sources of crude oil in the world.

Because the commercial development of the oil sands is in its infancy, and partly because of the remote location of the deposits, very few Canadians have had an opportunity to become well informed about this vast source of energy. For this reason, the Government of the Province of Alberta felt that it would be appropriate to prepare this description of the Alberta oil sands. We believe that it will serve as a useful input to the First Ministers' Energy Conference to be held in Ottawa on January 22nd and 23rd, 1974.

The subject matter covered in this report includes:

1. a brief description of the Alberta oil sands;
2. crude bitumen recovery and upgrading processes;
3. a brief history of crude bitumen recovery and upgrading;
4. the role of Alberta Energy Company Ltd. in oil sands development;
5. some environmental aspects of oil sands development;
6. manpower requirements for oil sands development;
7. historical research and future research needs regarding Alberta oil sands development;

8. expected timing and scope of further oil sands projects; and,

9. summary.

The Alberta Oil Sands are almost entirely owned by the people of Alberta by their provincial government pursuant to the terms of Confederation. The extent of freehold or non-government ownership in the Alberta Oil Sands is negligible.

The Alberta Oil Sands policy will form part of the Alberta Government's overall objective of working with the rest of Canada to ensure long term energy self-sufficiency for Canada consistent with Alberta receiving fair value for its resources.

Peter Lougheed
Premier of Alberta
January 1974

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SECTION I

A BRIEF DESCRIPTION OF THE ALBERTA OIL SANDS

The oil sands of Alberta represent one of the largest single sources of oil in the World. The deposits consist of a mixture of sand, mineral matter, water and crude bitumen (a heavy, black, asphaltic naphthenic base hydrocarbon which is very viscous and contains sulphur, nitrogen and trace metals). Films of water and crude bitumen surround each sand grain and some gas, usually air, is present between the grains. Synthetic crude oil, the ultimate product from crude bitumen recovery and upgrading can be refined to produce gasoline, jet fuel and other refined petroleum products and in this regard is similar to conventional crude oil. Synthetic crude oil is sulphur free which is a unique and important quality of the product in terms of ecological and environmental terms.

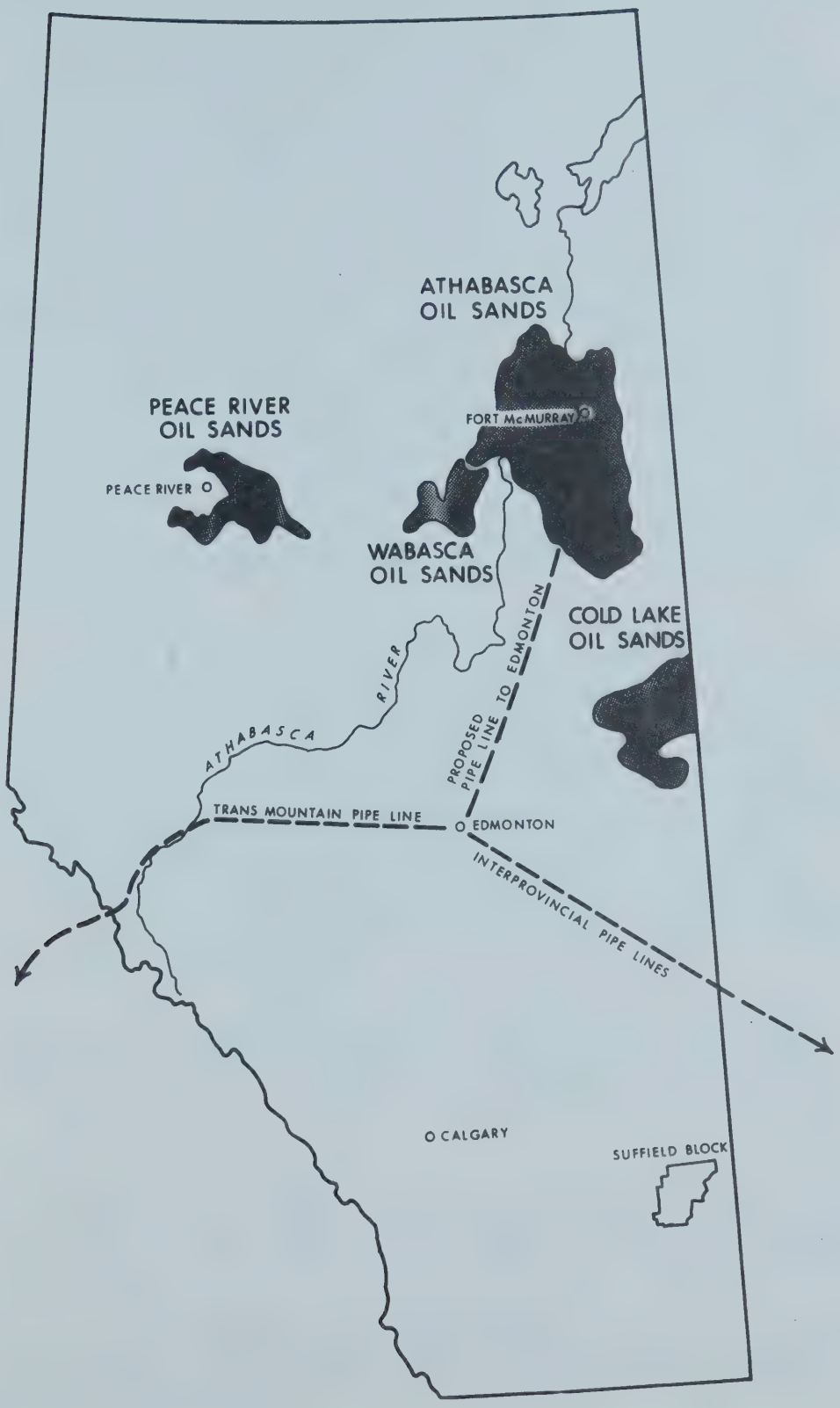
The oil sands extend over some 19,000 square miles of Northern Alberta, principally in the northeastern portion of the Province approximately 250 miles from Edmonton (see map, Figure 1). In the vicinity of the Athabasca River, the oil sands are located at or close to ground level. However, the bulk of the deposits underlie an overburden of muskeg, glacial till, Cretaceous bedrock and lean oil sand varying in depth from about 150 feet to 2500 feet. The thickness and quality of the deposits vary considerably.

The Alberta Energy Resources Conservation Board (the principal regulatory agency of the energy resource industries in Alberta) recently estimated crude bitumen in place at about 900 billion barrels which may ultimately yield recoverable reserves of synthetic crude oil in the amount of 250 billion barrels.

The Alberta Board's appraisal covers the in-place reserves of crude bitumen in the four principal oil sands deposits

FIGURE 1

LOCATION OF ALBERTA OIL SANDS DEPOSITS



in Alberta, namely Athabasca, Cold Lake, Peace River and Wabasca (see Figure 1).

The Athabasca deposit is found under an overburden ranging from zero to 2000 feet. According to the Alberta Board the deposit is reasonably well delineated. The deposit covers 5-3/4 million acres of which ½ million acres is overlain by 150 feet or less of overburden. This ½ million acres is considered suitable for surface mining. The Alberta Board estimates the proved in-place reserves of crude bitumen in the Athabasca deposit at 74 billion barrels in the 0-150 feet overburden range and 552 billion barrels in the 150-2000 feet overburden range. Of this 74 billion barrels 38 billion barrels of crude bitumen has been estimated as proved recoverable[1/] which is expected to yield 26.5 billion barrels of synthetic crude oil.[2/] The Alberta Board is optimistic that 'in situ' methods will be developed to permit recovery of a substantial part of the crude bitumen in the deep deposits.

In 1972 the Alberta Energy Resources Conservation Board completed an appraisal of the Cold Lake deposits and estimated the proved in-place reserves of crude bitumen to be 164 billion barrels, none of which as yet are classed as proved recoverable. It would appear that the Cold Lake deposits extend into the Province of Saskatchewan but to date these estimated reserves in Saskatchewan apparently have not been quantified. In any event the Saskatchewan reserves would account for only a small portion of the total Cold Lake reserves.

The proved in-place reserves of the Peace River and Wabasca deposits have been estimated by the Alberta Board at 50 and 54 billion barrels, respectively, none of which are considered as proved recoverable.

1/ Based on only those sands containing 5 or more weight percent crude bitumen, under less than 150 feet of overburden, with an overburden to pay ratio of less than one, and a 90 percent mining recovery.

2/ Assuming a conservative 70 volume percent separation and conversion. Great Canadian Oil Sands Limited is now realizing a separation of crude bitumen and a conversion to synthetic crude oil of 69 percent.

The following tabulation summarizes the Alberta Energy Resources Conservation Board's most recent estimates by major deposit.

Deposit	Overburden Depth	Areal Extent	Crude Bitumen In-Place	Recoverable Crude Bitumen	Remaining Recoverable Synthetic Crude Oil
	(feet)	(M acres)	(billions of barrels)		
Athabasca	0-150	490	74	38	26.5
	150-2000	5260	552		
Cold Lake A	1000-2000	1800	118		
B	1000-2000	650	33		
C	1000-2000	710	74		
Buffalo Head Hills	500-2500	159	1		
Peace River	1000-2500	1180	50		
Wabasca A	250-2000	764	30		
B	1000-2500	1000	23	—	—
		12013	895	38	26.5

Source: Alberta Energy Resources Conservation Board.

The 26.5 billion barrels of remaining recoverable synthetic crude oil compares to remaining recoverable reserves of conventional crude oil in Alberta at the end of 1973 of about 7.0 billion barrels.

There are two basic and distinct methods for recovering crude bitumen from oil sands deposits: one presently in commercial use and the other in the research or pilot development state.

SECTION II

CRUDE BITUMEN RECOVERY AND UPGRADING PROCESSES

Crude Bitumen Recovery Techniques

A commercial process (the hot-water or Clark process) is available for extracting crude bitumen from the mineable portion of the Athabasca oil sands deposit. Open-pit mining coupled with hot-water extraction is presently in use at the Great Canadian Oil Sands operation near Fort McMurray, and a similar procedure will be used by Syncrude Canada Ltd. at its project which is presently under construction.

A second group of processes consist of extracting the crude bitumen without removing the sand or overburden. These are so-called "in-situ" processes which must be used where overburden thickness are too great for mining. As described in a later section, a number of companies are involved in researching and testing different types of "in-situ" processes, but none are considered to be commercial at present.

1. Open-Pit Mining

Based on the experience of Great Canadian Oil Sands Limited, open-pit mining of oil sands to recover crude bitumen is suited only where the deposits are exposed at ground level or where the overburden does not exceed 150 to 200 feet, or where the ratio of overburden to deposit thickness does not exceed 1:1 (provided the oil sands contain 8 percent or more by weight of crude bitumen). Crude bitumen saturation ranges from from 0-18 percent and averages 12 percent.

Open-pit mining and upgrading of crude bitumen consist of the following major steps:

(a) Land clearing, muskeg and overburden removal;

(b) Mining of oil sands;

(c) Transporting sands by conveyor systems or trains to crude bitumen extraction facilities;

(d) Separation of crude bitumen from sand by the hot-water process. The bitumen is recovered, dried and ultimately refined into synthetic crude oil;

(e) Transporting "tailings" (residual sand and water) to the mined-out area; and,

(f) Landscaping of mined-out area to return it to near its natural state.

The land must be cleared of any timber while the muskeg is frozen and ideally several years before the muskeg and overburden stripping is scheduled. Muskeg removal must be undertaken when the muskeg, which may be up to 20 feet thick, is frozen. The muskeg to be removed is drained by construction of a series of ditches. The frozen muskeg, once removed, must be contained in large dike-arrangements in order to prevent the material from flowing when thawed.

The overburden is removed using a large number of various types of earth-moving vehicles. The overburden is placed in the mined out area or is used to form mammoth dikes as much as 300 feet high and several miles in perimeter which are used to contain the "tailings".

Major problems associated with open-pit mining relate to "tailings" disposal and land reclamation of mined-out areas. Temporary disposal of tailings from the hot water extraction process is made in ponds outside the mine pit area which are created by dikes. Eventually the tailings will be placed in the mine pit once the pit is large enough to accommodate the mixture without interfering with on-going mining operations.

Because there is very little storage capacity between mining and crude bitumen recovery and because maintenance of such capacity is expensive, open-pit mining must operate on

a year-round basis in order to enable the crude bitumen recovery and refining processes to function continuously. For this reason, mining operations must take place under an extreme range of climate conditions, including winter temperatures that may drop to as low as -60 °F. The oil sands have been described as being brick hard in winter and like sticky molasses mixed with coffee grounds in summer. The sands are quite abrasive under these conditions; this results in high maintenance costs of mining equipment and conveyor systems.

The magnitude of the mining operation is illustrated by the fact that Great Canadian Oil Sands estimates that the mining of 150,000 tons of oil sand and overburden daily would fill one 12-mile train of 100-ton gondola cars. The proposed Syncrude operation would require a train twice as long.

2. 'In Situ' Recovery Techniques

Research has been undertaken for a number of years to develop technically and commercially feasible 'in situ' techniques for the recovery of crude bitumen in cases where open-pit mining is uneconomic because of the depth of overburden. 'In situ' techniques involve recovery of crude bitumen from deeply buried oil sands reservoirs without removing the overburden or the sands. Consequently, 'in situ' processes eliminate several major steps required under the open-pit mining technique including clearing of some land, draining and removing muskeg, removing overburden, mining the sands and crude bitumen separation at the surface.

'In situ' extraction may involve non-thermal techniques, principally the addition of a diluent to the reservoir, or thermal techniques involving hot water or high pressure steam injection into the reservoir, combustion,or nuclear

explosion in the reservoir. These techniques principally are directed towards reducing the viscosity of the crude bitumen. It must be either heated, dissolved or emulsified in order to cause it to flow to production wells. Procedures used to force the bitumen to flow include injecting heat or fluid into injection wells drilled through the overburden to the oil sands layer. By one technique these wells also may be producers. By the use of another technique flooding of the reservoir may be achieved through injection into one set of wells and the production of crude bitumen from a different set of wells. This method is similar to some secondary recovery methods used to increase conventional oil production from depleting reservoirs.

The crude bitumen produced in this manner is similar to the crude bitumen produced by the open-pit mining and hot water extraction technique.

Crude Bitumen Upgrading

The first major stage presently in use for upgrading crude bitumen to synthetic crude oil is coking, whereby the bitumen molecules are fragmented by thermal cracking. Coking may be a delayed or continuous process. Delayed coking is a batch process used by Great Canadian Oil Sands in which the crude bitumen is physically broken down into lighter materials and the heavy coke (including a portion of the sulphur and virtually all the metals) is deposited. The lighter materials are separated into light gases (used for heating fuels or charge gas), naptha (which can be upgraded to gasoline), kerosene (from which jet fuel is made), and gas oil (from which heating oil can be made). Syncrude plans to use fluid coking where thermal cracking will result in two streams, naptha and light and heavy gas oil, which will be individually hydrotreated. (A recently proposed technique for upgrading crude bitumen makes use of vacuum distillation and hydro-treating processes.

These processes have a potential of recovering more of the crude bitumen as synthetic crude oil.) The products are blended into synthetic crude oil.

SECTION III

A BRIEF HISTORY OF CRUDE BITUMEN RECOVERY AND UPGRADING

Realization of commercial development of the Alberta oil sands has taken a long time. The existence of the deposits has been known for about two hundred years as a result of a search for a suitable location for a Hudson Bay Company fort in the Fort McMurray area. They were also reported by the Geological Survey of Canada in 1884 and 1891. The first exploratory well was drilled in the late 1890's.

In subsequent years, a number of attempts were made to extract and upgrade crude bitumen from oil sands deposits. In 1930 International Bitumen Company became the first company to exploit the sands commercially which resulted in the extraction of several thousand barrels of tar. In 1936 and 1937 Abasand Oils Ltd. constructed a 250-ton-per day and a 400-ton-per day separation plant near Fort McMurray.

At the present time the Great Canadian Oil Sands Limited plant operates within a range of about 50,000 to 52,000 barrels per day. In addition, Syncrude Canada Ltd. is proceeding with the construction of a 125,000 barrel per day plant scheduled to commence operations in late 1977 or early 1978. A third company, Shell Canada Limited, has applied to the Alberta Energy Resources Conservation Board for a permit to construct a 100,000 barrel per day synthetic oil recovery project.

Great Canadian Oil Sands Limited

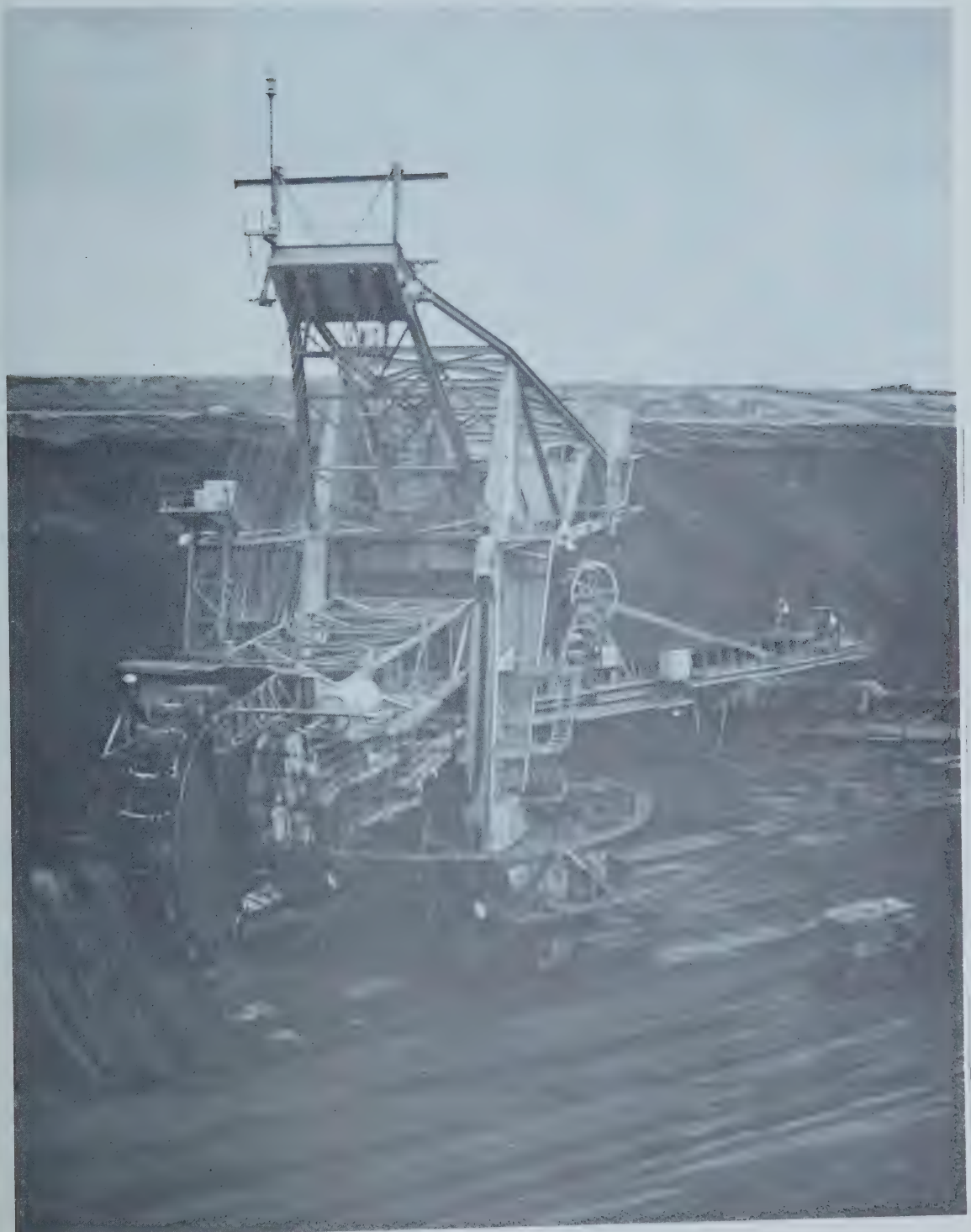
The Great Canadian Oil Sands Limited synthetic oil recovery development commenced operations in 1967 with an initial

design capacity of 45,000 barrels per day of synthetic oil. The facilities are located some 20 miles from Fort McMurray adjacent to the Athabasca River. Great Canadian is the only company presently involved in commercial production of synthetic crude oil from Alberta oil sands. Sun Oil Company, a U.S. corporation, holds over 96 percent of the company's outstanding shares.

In 1972 production averaged about 51,000 barrels per day of high gravity synthetic crude oil. Because of major plant maintenance work carried out in early 1973, the production rate for that year averaged just under 50,000 barrels per day. Production is expected to return to at least 55,000 barrels per day in 1974. The recovery in the form of synthetic crude oil is 47 weight or 56 volume percent of the crude bitumen in place which the Alberta Energy Resources Conservation Board considers satisfactory for a first commercial operation.

In 1972 Great Canadian applied to the Energy Resources Conservation Board for approval to increase the production rate to 65,000 barrels per day. Great Canadian believes this increase can be realized by "debottle-necking" existing operations plus the investment of relatively minor amounts of additional capital for new equipment. In 1973 the Alberta Board recommended to the Provincial Government that the authorized rate be increased to 65,000 barrels per day, limited to 23.7 million barrels per year. Alberta Government approval was subsequently received.

The mining operation is basically achieved by the use of two giant bucket wheel excavators and one smaller bucket wheel. Each of the larger bucket wheels weighs about 1800 tons and features a 33 foot diameter wheel on the end of a long boom. The mined sand is transported to the extraction plant by a series of conveyor belts, up to six feet in width.



Mining Wheel – used for the extraction of oil sands by G.C.O.S..

Unrefined tar – being transported from the mining site to the Great Canadian Oil Sands Plant.

Crude bitumen extraction is accomplished by mixing the sand with hot water and a small amount of caustic soda. By means of separation cells the crude bitumen is drawn off, deaerated, mixed with diluent and then centrifuged. The resulting product is stored prior to upgrading based on delayed coking and fractionating techniques.

The tailings stream at Great Canadian is delivered to the tailings pond at the rate of 24,000 gallons per minute. The pond is surrounded by a dike 210 feet high and three miles in circumference made from the coarse fraction of the tailing sand.

During the early years of operation the company experienced a number of technical problems requiring major modifications of power plant boilers, redesign of excavator buckets and teeth, redesign and expansion of conveyor systems and increased capacity of extraction plant and sand disposal and settling facilities. In order to overcome the almost impossible problem of digging oil sands during winter months, the deposit is now dynamited during the warm seasons, which has the effect of fluffing up the deposit and permitting air to permeate the sand and act as an insulator.

As a result of these problems the company has incurred an accrued deficit totalling about $88 million as at December 31, 1972. These accumulated deficits reflect the highly pioneering nature of initial operations. Great Canadian has estimated that a price of $8.50 per barrel will be required to provide an adequate return on investment. The total shareholders' equity (including accumulated deficit) approximated $300 million as at December 31, 1972. Approximately 85 percent of the original construction costs of nearly $190 million were spent in Canada and approximately the same percentage of expenditures for equipment materials and services, which have been as high as $50 million per year, has been spent in Canada,

reflecting the major economic impact of such a project on the nation.

Great Canadian pays a royalty rate to the Alberta Government of 8 percent of the first 900,000 barrels of monthly production and 20 percent of all production in excess of 900,000 barrels. The previous Government of Alberta had reduced by 50 percent the royalty payable under the royalty regulation for a period of three years commencing April 1, 1970. Effective April 1, 1973 the present Government eliminated the royalty reduction and the royalties payable by Great Canadian reverted to the original schedule.

Syncrude Canada Ltd.

Syncrude Canada Ltd. is an Alberta incorporated company which will be the operator of an oil sands development to be located at Mildred Lake, some 25 miles north of Fort McMurray, Alberta, on behalf of the following consortium of four lessees: Imperial Oil Limited, Canada-Cities Service Ltd., Atlantic Richfield Canada Ltd. and Gulf Oil Canada Limited. The Syncrude development will commence operation in 1977, and will have an ultimate production rate of 125,000 barrels per day of synthetic crude oil. Initial commercial production in 1978 is expected to be at the rate of 50,000 barrels per day, increasing to 90,000 per day in 1979, 105,000 barrels per day in 1980 and 1981, 115,000 barrels per day in 1982, 120,000 barrels per day in 1983 and 125,000 barrels per day thereafter.

Total capital costs of the Syncrude project are expected to be approximately one billion dollars. (These estimates exclude costs of external roads, the pipeline, housing and the power plant.)

The open-pit mining operation will utilize large drag-lines rather than bucket wheel excavators. To minimize the impact of failure of individual components, Syncrude has designed its facility to have two trains in the hope that should

there be problems in one section of the plant, the remaining portion would continue in operation. The extraction process will be the same as the Great Canadian Oil Sands hot water separation.

Syncrude will use fluid or continuous coking in the processing plant. The fluid cokers are expected to be the largest in the world as will be numerous other components. This poses potential risks due to the relative unproven workability of very large individual components.

The Alberta Energy Resources Conservation Board estimates that overall recovery of synthetic crude oil will be 56 weight or 65 volume percent of the in-place crude bitumen.

Under the Agreement between the Province of Alberta and Syncrude the Province will be a joint venture participant and in return for its interest in the leases and the leased substances is to receive 50 percent of the pre-tax profits remaining after deducting from total revenues each year:

(a) operating costs;

(b) depreciation or recovery of capital; and,

(c) an allowance for capital employed, equivalent to 6 percent on the total capital employed.

Determination of revenues, costs and hence profits will be made through use of very detailed accounting regulations now being developed. Revenues will include income from the sale of all substances which the lessees have the right to recover from the leases (in addition to synthetic crude oil this would include sulphur, coke, metal by-products, etc.). Prices to be used in determining revenues are to be fair market values at the plant gate.

Other major elements of the Syncrude-Alberta Government Agreement include:

1. The Province shall receive (in satisfaction of its interest as a joint venture participant) during each year, a share of all leased substances recovered and sold and which have an aggregate value equal to 50 percent of the net profit. Whenever the Province does not take its share of the leased substances, the lessees shall dispose of such share on behalf of the Crown.

2. The Province shall have the right after the fifth anniversary of the start of production to terminate the joint venture and to elect to take a gross production royalty equal to 7½ percent of the total annual production of the leased substances.

3. The Province has the right to require a review and change of the joint venture provisions at any time, in the event of changes in Federal Government policy or laws which could materially affect the position of the Province or any of the other parties to the joint venture.

The Alberta Energy Company Ltd. (recently formed by the Province of Alberta as a corporate vehicle whereby Albertans will have the opportunity to participate in resource development projects) will own 80 percent of the common carrier pipeline delivering synthetic crude oil from Fort McMurray to Edmonton, 50 percent of the Syncrude power plant, plus an option to acquire up to a 20 percent interest in the Syncrude plant. The Alberta Energy Company and its specific investment interest in the Syncrude project are discussed in more detail in the next section.

Shell Canada Limited

Shell Canada Limited and Shell Explorer Limited have submitted an application to the Alberta Energy Resources Conservation Board for a third commercial mining project, some 45 miles north of Fort McMurray. Public hearings related to this application commenced on October 9, 1973 and were completed in early November after a three week adjournment. Shell proposes the production of 100,000 barrels per day of synthetic crude oil commencing in 1980 and reaching full scale in 1982. Construction is scheduled to commence in 1976. Shell would use drag lines

for mining and overburden removal, front-end loaders for re-handling and a rail system for haulage. It would follow Great Canadian and Syncrude in its use of the hot water extraction and froth separation processes. Shell proposes to upgrade the recovered crude bitumen by vacuum distillation, hydrotreating and hydrocracking. Present estimates indicate a capital cost of the Shell project in the order of $700 million or more.

SECTION IV

THE ROLE OF ALBERTA ENERGY COMPANY LTD. IN OIL SANDS DEVELOPMENT

The Alberta Energy Company Ltd., recently formed by the Government of the Province of Alberta, will have a substantial investment position in various aspects of the Syncrude project. These and other proposed Alberta Energy Company Ltd. investments are described in more detail in this section following a brief description of Alberta Energy Company Ltd.

Alberta Energy Company Ltd.

An important objective of the present Government of the Province of Alberta has been to provide Albertans with opportunities to make equity investments in Alberta energy resources developments. In line with this objective the Government announced the formation of Alberta Energy Company Ltd. in September 1973. During the 1974 sitting of the Alberta Legislature the Government will introduce an act to establish the Company.

Through investment in this Company, Albertans will have the opportunity to benefit directly from resource development projects. The Alberta Energy Company Ltd. will represent a unique partnership between the Government of Alberta and Alberta citizens. The Government will own 50 percent of the shares in the Company, thereby assuring that meaningful and effective control of the company will always remain in the hands of, and will be directly responsive to, the interests of Albertans.

The financing arrangements will be designed to attract first-time investors in Alberta. An installment purchase plan will be provided, in much the same manner as many Albertans currently purchase Canada Savings Bonds. The issue of Alberta Energy Company Ltd. shares will be set in keeping with the objective of

obtaining wide distribution of share ownership. Also, total share holdings of any one investor will be limited to 1 percent of shares issued. Every Albertan who applies and qualifies will be able to purchase at least a minimum number of shares. Once the initial offering has been distributed, the shares will be allowed to trade freely in Canada. Voting shares will be restricted to Canadians or Canadian shareholders.

The capitalization of Alberta Energy Company Ltd. will be $500 million of which $250 million will be provided by the Government of the Province of Alberta and an equal amount by Alberta and other Canadian investors. Initially, $150 million will be raised in 1974 through the sale of shares.

Initial Investments of Alberta Energy Company Ltd.

The initial investments proposed for Alberta Energy Company Ltd. have been selected with a view of acquiring a balanced portfolio as well as participating in those energy projects that have a particular interest to Albertans.

Alberta Energy Company Ltd. will provide an opportunity for the small investor to participate in projects of the magnitude of Syncrude, development of the sizeable Suffield (British Block) reserves of natural gas and the Pan-Alberta project, which are described briefly below:

1. Suffield (British Block) Natural Gas Reserves

The Suffield (British Block) is a 1,000 square mile block located about 30 miles north of Medicine Hat in south-eastern Alberta (see Figure 1). It has been estimated that about 4 trillion cubic feet of recoverable natural gas reserves underlie the Suffield Block. The mineral rights to the Suffield Block are owned 95 percent by the Government of Alberta. The surface rights are owned by the Federal Government, large portions of which are currently leased to the British Army for training purposes.

Alberta Energy Company Ltd. will acquire from the Alberta Government the natural gas rights to the Suffield Block. The potentially valuable reservoir of natural gas will be developed in conjunction with private industry. The company will not compete with private industry in the normal exploration and development programs in the energy field.

2. Pan-Alberta Gas Ltd.

Pan-Alberta is a gas marketing company sponsored by The Alberta Gas Trunk Line Company Limited. Pan-Alberta recently applied to the National Energy Board for a permit to export about 0.9 Tcf of surplus Alberta natural gas to markets in California over a six-year period commencing November 1, 1974. On January 8, 1974 Pan-Alberta and Gaz Metropolitain, Inc. of Montreal announced a preliminary agreement for the long-term supply of 4.3 Tcf of natural gas from Alberta to Quebec markets during the period November 1, 1974 to November 1, 2000.

In December 1973 Alberta Energy Company Ltd. joined The Alberta Gas Trunk Line Company Limited as a shareholder in Pan-Alberta. Prior to Alberta Energy Company Ltd. becoming a shareholder, Alberta Gas Trunk Line was the sole shareholder in Pan-Alberta, with 6,000 shares. Alberta Energy Company Ltd. will purchase 6,000 shares immediately. Under the purchase agreement, each will puchase equal numbers of additional common shares at a later date. Shares will also be made available to the public in Canada, with particular attention to residents of Alberta and to the holders of Class A Common shares of Alberta Gas Trunk Line.

Alberta Gas Trunk is owned over 20 percent by individual Albertans, and, because of the holdings of institutional investors mostly headquartered in Ontario and Quebec, about 80 percent by national investors across Canada.

3. Syncrude Canada Ltd.

Alberta Energy Company Ltd. will provide the means of ensuring the participation of Alberta citizens directly in the

following three aspects of the Syncrude development:

(a) Fort McMurray-Edmonton Pipeline

The Company will acquire an 80 percent interest in the 272 mile common carrier pipeline for delivery to Edmonton of all the synthetic crude oil produced in the Fort McMurray area. Initially the 30" diameter pipeline will have a capacity of 175,000 barrels per day. Capacity will be increased in stages by the addition of pumping capacity plus a 32" loop, which will be built in 1984-5.

The pipeline tariff agreement is designed to assure that Alberta Energy Company Ltd. receives a fair return and that Syncrude and any other users pay a reasonable tariff. The rate structure on the Fort McMurray-Edmonton line will be designed so that revenue from the Syncrude plant will cover operating costs, debt interest, recovery of capital investment and provide a reasonable return on investment. Since the pipeline that is built may well be constructed to carry the anticipated production from plants additional to Syncrude, provision has been made so that the tariff applicable to Syncrude will relate to the 125,000 bbls/day planned capacity of that plant. If, for example, the line that is constructed could carry in excess of 125,000 bbls/day, charges to Syncrude will be only reasonable charges for a 125,000 bbls/day line even though the throughput may not exceed 125,000 bbls/day for some years. On the other hand, Syncrude's crude transportation costs will be based on 125,000 bbls/day of throughput even if this level is not achieved.

The pipeline is considered to be a low risk venture and should be a major source of profits and funds for further development projects by Alberta Energy Company Ltd.

(b) Syncrude Power Plant

The Company will acquire a 50 percent interest in the $100 million power plant, an integral part of the extraction plant

providing both electrical power and steam necessary in the recovery of crude bitumen. This investment is of a low-risk type and will provide a fixed rate of return.

(c) Option to Acquire Equity Position in Syncrude Plant

The Company has an irrevocable option to acquire up to a 20 percent interest in the Syncrude plant, exercisable at any time up to the commencement of production. The Syncrude plant itself is viewed as carrying the highest potential risk of all three aspects of the project. The Company does not need to exercise its option until the plant is on production, when capital costs, crude oil prices and other important factors should be much more certain than at present. The lessees' interest covered by the option includes the project site, the leases and rights and all facilities acquired or constructed as part of the Syncrude project.

SECTION V

SOME ENVIRONMENTAL ASPECTS OF OIL SANDS DEVELOPMENT

Large scale recovery and upgrading of crude bitumen from oil sands deposits in Alberta, whether by open-pit mining or 'in situ' recovery, could have an adverse impact on the environment in the area, unless preventative measures are implemented. In order to provide an indication of the nature and magnitude of potential environmental problems associated with oil sands development, the Government of Alberta commissioned a study prepared by Intercontinental Engineering of Alberta Ltd. entitled "Environmental Study of the Athabasca Tar Sands," which was completed in March 1973. In additional, the Government has received other helpful reports from committees of the Government which also deal, in total or in part, with environmental aspects of oil sands development. The Intercontinental study was used as the basic source of information for this section of this report.

Broadly speaking the terms of reference of the study covered:

1. identification of the various methods that could be used for oil extraction and their comparative merits with respect to minimum adverse effects on the immediate as well as the surrounding environment;

2. recommendation of recovery and upgrading methods and procedures that should be employed to eliminate or minimize adverse effects on the environment;

3. recommendation of constraints to be applied on plant location, plant capacity and number of plants per given area;

4. recommendations as to which effects or problems should be given priority in research efforts; and,

5. provision of the basis for the Government of Alberta to select optimum strategies in the implementation of long term tar sands development policies.

A major part of the Intercontinental study dealt in some detail with a variety of environmental components and conditions of the area (biological, human and physical) which may be adversely affected by a variety of activities (exploration, plant construction, preparation for surface mining, overburden stripping, blasting, surface mining, hot water extraction, tailings placement, reclamation, bitumen processing, utilities, plant locations and size, in situ recovery and direct coking).

Environmental Components and Conditions of the Area

Because of space limitations it is impossible to identify and discuss all environmental components and conditions referred to in the Intercontinental report. However, regarding the environment aspects the report commented on a number of components and conditions, including:

1. Physical Environment

(a) Surface water - The Athabasca River and its drainage basin (which involves lakes, rivers, streams) are a vital part of the total ecological area of the Athabasca Oil Sands. The Athabasca River itself is a very key factor since it would likely be the principal source of water for industrial and municipal use. The report suggested that a much more detailed definition of the characteristics and conditions of these drainage basins will be required to permit the planning of future industrial development in the area.

(b) Groundwater - Detailed information on subsurface water movement patterns is not yet available. The limestone underlying the tar sands is perforated in places with sink holes which could act as upward conduits for saline water and downward conduits for drainage water. The report suggested that a survey should be

conducted to establish the theoretical groundwater flow patterns especially for sands leases contemplated for development.

(c) Atmosphere - Weather patterns in the oil sands area are such that airborne emissions are normally dispersed effectively during the summer. However, temperature inversions, winds and ice fogs during the winter months greatly reduce the atmosphere's ability to disperse airborne emissions. Severe ice fogs may be caused by the large quantities of water vapour discharged to a localized atmoshpere as a result of oil sands operations. According to the report, additional data on dispersion problems will be necessary.

(d) Ground Surface - Most of the surface soil in the area is reasonably well stabilized by muskeg and forest cover. The muskeg contains 30 percent or more water and will not support vehicular traffic except when it is frozen.

(e) Underground - The sediments overlying the Precambrian have a maximum thickness of about 3000 feet at the southwestern corner of the Athabasca Oil Sands area, thinning to zero at the northeast edge of the area.

2. Human Environment

This section of the Intercontinental report dealt with municipalities, education, health and safety, mobility, occupational patterns and recreation, including the need for coordinated industrial and regional planning related to many of these subjects.

3. Biological Environment

This section of the report dealt with research and constraints needed to protect the flora and the fauna in the area of oil sands development.

Oil Sands Activities Which May Cause Environmental Impact

The various types of activities identified in the Intercontinental report were referred to earlier in this section. Once

again because of space limitations only a few of these activities or recommendations relating to them can be identified.

1. Plant Construction

The report recommended that a greater emphasis should be placed upon preventing ecological damage, and therefore applications for construction of oil sands plants should include comprehensive environmental impact analysis. The report also suggested that guidelines must be established regarding permissible size, location and density of oil sands plants.

2. Hot Water Extraction of Crude Bitumen

The report recommended that appropriate precautions should be taken to ensure that approved water consumption plans do not cause any significant lowering in the level of lakes or rivers.

3. Tailings Placement

The report suggests that the disposal of tailings from the hot water extraction process represents the most imminent environmental constraint to the future expansion of this recovery method, and that the present technology for handling tailings does not provide adequate clarification of the water to permit total recycling, and because of the presence of contaminants, discharging of tailings water into the Athabasca River is precluded. Intensive and coordinated research by qualified agencies will be required to eliminate the continuous accumulation of liquid tailings.

4. Reclamation

The report recommends that a long-term field research program must be initiated promptly to develop reclamation procedures and standards.

5. Utilities

The report suggested that constraint will be necessary to control stack effluents and suggested basic approaches to controlling emissions.

6. In Situ Bitumen Recovery

The report suggested that 'in situ' methods will result in water displacing about 60 percent of the bitumen in place. In view of the extent and thickness of the sands some research should be directed to determine the ultimate possible effects upon the water table and the groundwater flow pattern.

Principal Recommendations and Observations of Intercontinental Engineering Study

The principal recommendations of the Intercontinental environment report are summarized as follows:

1. The existing system for plant permits be expanded to include exploration, land clearing and overburden drainage.

2. Future permit applications be required to include more comprehensive environmental impact analysis.

3. Surface mining be prohibited in certain areas.

4. Size, location and density of oil sands plants to be contingent upon compliance with ambient air and water standards.

5. Stricter controls to be placed on tailings disposal.

6. Sulphur content of fuels for power generation to be limited.

7. Strict controls to regulate land clearing (ahead of surface mining) and overburden stripping.

8. Stream diversions to be strictly regulated.

9. Consumption of water from Athabasca River to be limited.

10. Tighter controls to be exercised over use of volatile liquids in processing.

11. A number of recommendations relating to research programs,

planning of land use and establishment of measuring and monitoring facilities.

The report also presented the following observations on the responsiblities for implementing the recommendations:

1. That the Alberta Government and Lessees must devise an effective means of cooperating in planning the development of the oil sands.

2. That the industry be recognized as a distinct new entity requiring specific Government regulations and legislation.

3. That developers must assume responsibility for pollution control at the source.

4. That the Alberta Government must establish pollution control standards and share responsibility for monitoring with industry.

5. That an oil sands research centre be established in Alberta with both industry and governments participating.

The Intercontinental report contained some further general observations, including:

1. the environmental effects of eventual multi-plant operations over the extent of the oil sands could be enormous, unless preventive measures are implemented;

2. the oil sands industry must improve its technology significantly to protect the environment against the possible impacts of the large scale expansion contemplated;

3. a unique opportunity exists for the comprehensive planning of orderly industrial and regional development in the oil sands area. New government policies will be essential to guide the industrial and regional development of the area towards the long term interests of Albertans and other Canadians.

SECTION VI

MANPOWER REQUIREMENTS FOR OIL SANDS DEVELOPMENT

The potential effect of oil sands development on the size of the Alberta labour force and the Province's population is expected to be substantial. Alberta Energy Resources Conservation Board data and projections, along with other source information have been used to illustrate what reasonably may be expected to happen to the Alberta labour force and population as a result of oil sands development during the balance of this century. These results should be viewed as directional or order-of-magnitude expectations rather than precise forecasts based on comprehensive analysis.

As discussed in Section VIII, the Alberta Board estimates that Alberta oil sands proven recoverable reserves are adequate to support 20 to 30 plants with capacities of 100,000 to 150,000 barrels per day and that approximately one plant a year will be constructed in the 1980-1985 period. It has been assumed that construction of additional plants will continue at the rate of one plant a year from 1985 through to 2000.

Current Alberta Labour Force and Population Data

The Review of Business Conditions, published by the Alberta Department of Industry and Commerce estimated the June 1, 1972 population at 1,655,000 (October, 1973, 1,696,000).[1/] The labour force at that date totalled 688,000 comprising 461,000 men and 227,000 women. The unemployed numbered 30,000 or 4.4 percent of the labour force.

1/ Canadian Statistical Review, Weekly Supplement, December 28, 1973.

Construction Labour Force Requirements - Oil Sands Plants

The Alberta Energy Resources Conservation Board estimates that 5000 man years will be required for the construction of an oil sands plant of 100,000 barrel per day size. Consequently, if one plant annually is constructed in the 1980-2000 period, an average work force of 5000 will be required for that full period. A high proportion of the construction force must be journeymen tradesmen. Syncrude estimates this percentage at approximately 65.

Operational Work Force - Oil Sands Plants

Utilizing Alberta Energy Resources Conservation Board estimates of 1500 permanent employees per oil sands plant and assuming these plants total 20 in the year 2000, the direct operating labour force of oil sands plants would number 30,000 in that year.

Total Employment Resulting From Oil Sands Activities

In his November 1971 study, The Regional Economic Impact of the Syncrude Canada Ltd. Project, Dr. E. J. Hanson, Professor of Economics, University of Alberta, estimates that the Syncrude Project will result in total new employment in Alberta of 9,500 in the first full year of operations and 9,000 thereafter. If 20 plants are operational by the year 2000, and using Dr. Hanson's Syncrude figure for each plant, direct and indirect jobs in Alberta resulting from oil sands activities will total 180,000. This is equal to 26 percent of the mid-1972 Alberta labour force.

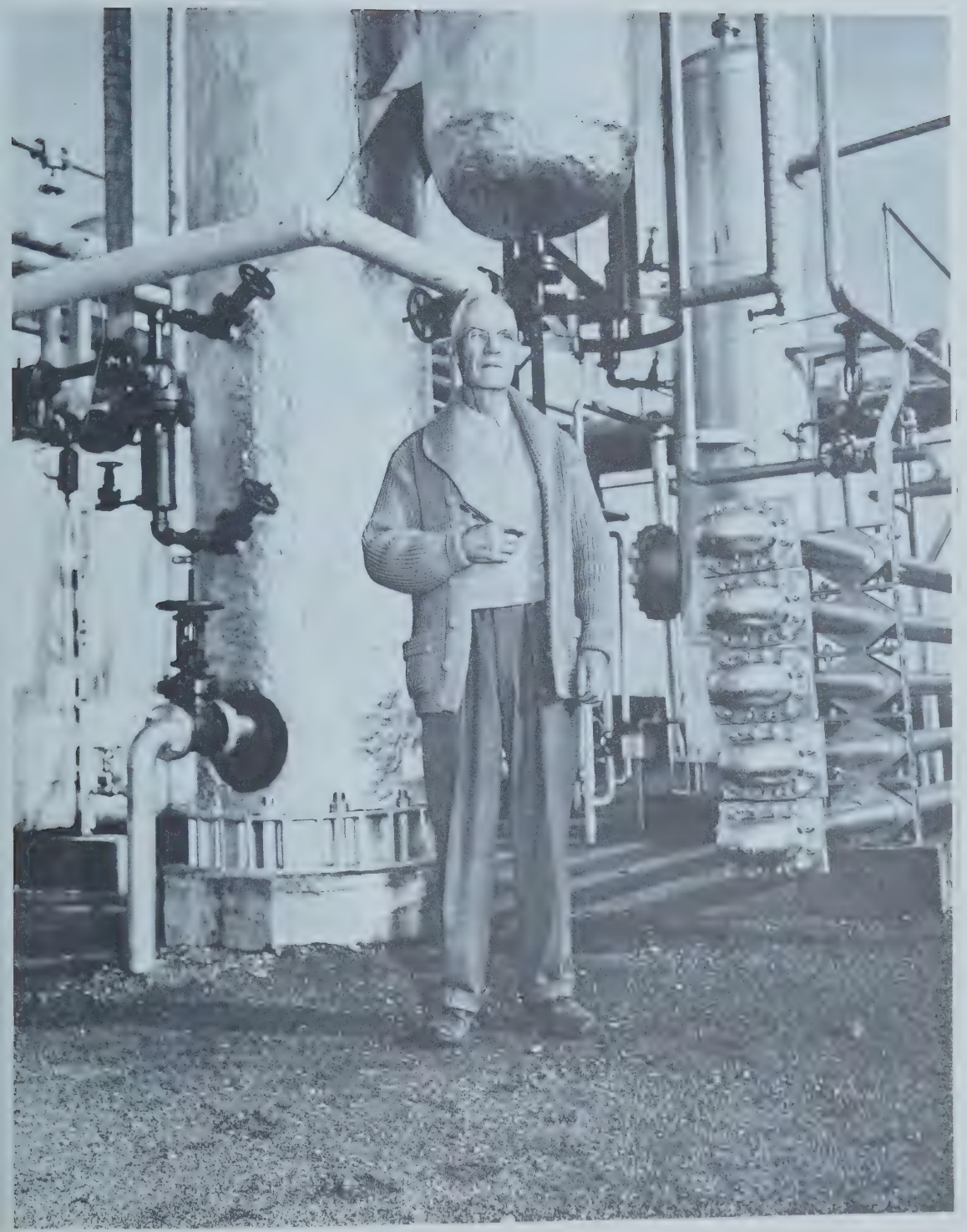
Availability of Work Force from Within Alberta

Studies done by Syncrude Canada Ltd. relative to its new oil sands plant indicate that in all employment categories (management and professional, construction and operational) that personnel needs cannot be met from within the Province of

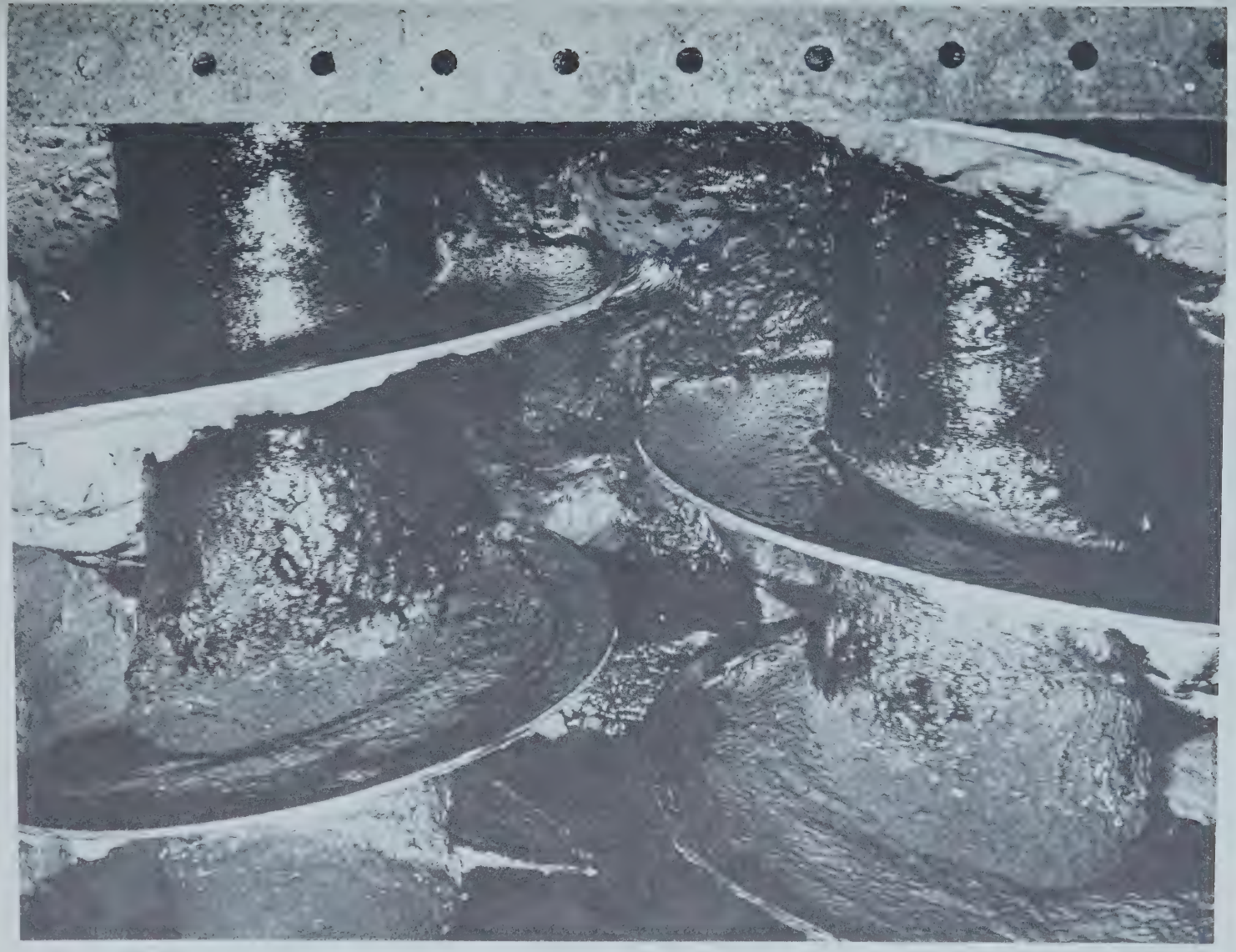
Alberta. Syncrude therefore expects that it will be necessary to do extensive recruiting both within and beyond the borders of Alberta. It would appear that rapid development of new plants commencing in the late 1970's or early 1980's could create severe problems of labour supply, particularly since a large percentage of both construction and operating employees will require specialized skills. New training facilities within the Province and extensive instructional programs appear essential should rapid oil sands development occur.

Alberta Population Increase Attributable to Oil Sands Plants

Twenty operational oil sands plants in the year 2000 would result in estimated total direct and indirect employment attributable to oil sands of about 180,000. Using a ratio of population to labour force of 2.5:1.0 (the approximate figure used in Dr. Hanson's study) the estimated Alberta population resulting from oil sands operations in 2000 would be 450,000. This is equivalent to 27 percent of Alberta's October 1973 population.



Dr. Karl A. Clark – Alberta Pioneer in the Development of Oil Sands Technology.



Hot Water Separating Process – in its historic experimental stage at the Bitumount Pilot Plant, a project of the Alberta Research Council.

SECTION VII

HISTORICAL RESEARCH AND FUTURE RESEARCH NEEDS REGARDING ALBERTA OIL SANDS DEVELOPMENT

Historical Research

Since the publication by the Geological Survey of Canada in the 1890's of writings about the Alberta oil sands there have been numerous attempts to recover and upgrade bitumen from the deposits. In addition, a significant amount of basic and applied research into recovery and upgrading has been undertaken.

In the 1920's, Dr. Karl Adolph Clark, a scientist with the Research Council of Alberta, began a long and distinguished career of research into methods of oil-sand separation, including hot water separation techniques, whereby the sands are mixed with hot water and some chemicals causing a crude bitumen froth which is recovered and upgraded. The limited-success attempts by International Bitumen Company and Abasand Oils Ltd. during the 1930's to commercially develop oil sands deposits were discussed in Section III.

Since 1948, the Research Council of Alberta has conducted research and pilot plant experiments into ways of extracting crude bitumen from the oil sands deposits, including large scale hot water separation tests at Bitumount. The methods researched for crude bitumen recovery have included underground combustion, steam or emulsion injection and underground atomic explosions.

In addition to the research undertaken by Great Canadian and Syncrude a number of other oil companies have been making significant research expenditures into oil sands mining and crude bitumen recovery and upgrading.

For example, since 1964 Imperial Oil Limited has spent about $15 million on research and a pilot plant project

at its Cold Lake facilities, 140 miles northeast of Edmonton using steam injection to reduce viscosity. The company has applied to the Alberta Energy Resources Conservation Board for approval to add facilities which will increase production to 4000 barrels per day and to continue production for a further five years.

Shell Canada Ltd. has recently undertaken considerable research into 'in situ' steam injection tests at a reported cost of $1.5 million over and above earlier experimental work. If the results of the latest program warrant further research, the company plans to undertake an expanded injection and production well program over three years at a cost of $15 million or more. According to the Alberta Energy Resources Conservation Board, if the latter program is successful, it could lead to an application to the Alberta Board by Shell about the end of the decade for a permit to remove bitumen by 'in situ' techniques.

Amoco Canada Petroleum Company Limited has spent $9 million since the late 1950's and plans to spend a further $13 million on 'in situ' recovery methods including field testing its COFCAW process (Combination of Forward Combustion and Waterflooding). Amoco employs a patented hydrofrac process followed by injection of air (to initiate and maintain underground combustion) and water.

A number of other companies, including Texaco Canada Limited, Petrofina Canada, British Petroleum Company Ltd., Chevron Standard Limited and Great Plains Development Company of Canada Ltd. have been active in oil sands recovery research.

Future Research Needs

There is a need for accelerated research, particularly regarding the adaptation of 'in situ' thermal recovery technology

to the unique problems associated with oil sands deposits.

The research required to resolve the technological, environmental and social problems associated with successful development on a large scale of the oil sands potential in Alberta will require expenditures of many millions of dollars by potential developers, other organizations and government agencies at various levels. There is some urgency to accelerate these research activities in order that useful results will be available in advance of large scale developments. The long term benefits to Canada would be maximized if this research is undertaken in Canada by Canadians to the fullest extent possible. In order to optimize the results of the overall research efforts being undertaken by the diverse groups identified above, there should be some basis for coordinating exchange of areas of mutual interest and common research to the benefit of all concerned without impeding the individual and proprietory interests of individual projects. Duplication of non-proprietory research should also be avoided.

The Alberta Oil Sands Technology and Research Authority

The Government of Alberta recently announced the creation of the Alberta Oil Sands Technology and Research Authority which will be under the guidance of the Department of Mines and Minerals. An Act containing specific terms of reference to guide the operations of the Authority will be presented to the 1974 Legislative Session.

The Authority will be the initial step in "Energy Breakthrough", a Government of Alberta project with important responsibilities to achieve, as rapidly as possible, a breakthrough in technology and research that is essential if the recovery of crude bitumen from Alberta's deep-seated oil sands is to be achieved. As pointed out in earlier sections, considerable research expenditures will be required if crude

bitumen is to be recovered by 'in situ' methods. Creation of the Alberta Oil Sands Technology and Research Authority plus additional steps in "Energy Breakthrough" represent a major development in the Government's responsibility to manage the energy resources owned by Albertans, and to make the oil sands an accepted, reliable and proven part of the Canadian and world energy supply. "Energy Breakthrough" should have a significant impact on the North American energy picture.

As pointed out in Section VIII, Alberta's oil sands will serve an increasingly important role in Canada's long-term security of petroleum supply and self-sufficiency. For this reason, the Government of Alberta has taken steps to assure that development of the Alberta oil sands will be managed in such a way as to provide maximum benefits to Albertans who own the resource and to all Canadians who will utilize the resources.

The Government has committed a $100 million dollar fund to the Authority to be available for technology and research over the next five years. Through the efforts of the Authority the knowledge to harness the full Alberta oil sands potential can be accumulated and coordinated. The Authority will have the responsibility to establish a fair and equitable procedure for accumulating and pooling existing and future technological developments in this field. Private industry, particularly existing lessees, will be encouraged to expand their research efforts in cooperative programs between industry and the Authority.

The Government recognizes the significant contribution by industry (in terms of effort and expenditures) to research on oil sands technology. Arrangements will be made with industry to protect the ownership interest and competitive position of individual companies' substantial investments in research undertaken to date. Special liaison will be required with the Alberta Energy Resources Conservation Board, the

Alberta Research Council, Alberta universities and various government departments. The Authority may enter into arrangements with other interested governments to develop a coordinated approach to oil sands research, to avoid duplication of research efforts, and to establish priorities that will meet the Alberta and other Canadian public interest.

Establishment of the Authority and the funds provided for its operation should provide Albertans the opportunity to gain the expertise necessary to develop the oil sands to their full potential in an orderly but urgent manner.

SECTION VIII

EXPECTED TIMING AND SCOPE OF FURTHER OIL SANDS DEVELOPMENT

The major purpose of this section is to indicate the expected rate of development of Alberta oil sands reserves, particularly over the next 10 to 15 years. In order to provide some perspective as to the future needs for oil sands developments the expected outlook for the conventional crude oil industry in Alberta is discussed in terms of reserves, production, market demand and productive capacity. This analysis indicates that the conventional crude oil industry is approaching its productive capacity. The discussion of the outlook for the conventional industry and for the Alberta oil sands development are based primarily on studies undertaken by the Alberta Energy Resources Conservation Board.

Conventional Oil Industry in Alberta

Proved remaining recoverable reserves in Alberta at December 31, 1972 amounted to 7.1 billion barrels down from the peak of 7.5 billion barrels in 1969. The decline in remaining reserves is attributed to: (1) a comparatively low annual discovery rate over the period and (2) high annual production resulting from rapidly growing demand for Alberta oil principally from the United States, as shown below:

	Production (MMBD)			Increase (%)	
	1971	1972	1973 (est.)	1971-1972 Increase	1972-1973
Conventional Crude Oil	0.97	1.16	1.45	20	25
Pentanes Plus	.12	.16	.22	31	5
Synthetic Crude Oil	0.04	0.05			
	1.13	1.37	1.67	21	22

Source: Canadian Petroleum Association 1972 Statistical Year Book for 1971 and 1972 data; Alberta Energy Resources Conservation Board for 1973 estimate.

The Alberta Energy Resources Conservation Board predicts that Alberta's proved remaining recoverable reserves will continue to decline. Although there may be some increases in crude oil discoveries and further gains through new and expanded enhanced recovery operations, growth in initial recoverable reserves is expected to be only in the range of 200-300 million barrels per year over the next decade, which will be more than offset by anticipated production in excess of 500 million barrels per year. The Alberta Board further predicts that proved remaining recoverable reserves will drop to between 6.0 and 6.6 billion barrels by 1975, 3.8 to 5 billion barrels by 1980 and 2 to 3.5 billion barrels by 1985.

According to the Alberta Board, the province's wellhead productive capacity for conventional crude oil is approaching full utilization as a result of very rapid increases in the demand for crude oil, less favorable performance than previously projected for some major oil reservoirs such as the Pembina Cardium Pool, low rates of discovery of new reserves, and delays in eliminating bottlenecks in production facilities. As a result of this trend toward full utilization of wellhead productive capacity, it is expected that the existing prorationing system will be replaced by a system of maximum rate limitations for those pools where rate restrictions are necessary to avoid waste, and good production practice provisions where oil recovery is less sensitive to the rate of production.

The significance of Alberta's wellhead production approaching productive capacity is evident from the fact that Alberta accounts for about 80 percent of Canada's total conventional and synthetic crude oil and equivalent production. The ultimate major destinations of crude oil produced in Alberta over and above Alberta's own needs, include British Columbia, Ontario, exports to the Pacific Northwest states and to the Midwest area of the United States. The Alberta Energy Resources Conservation Board assessment of the supply and disposition

of crude oil and equivalent for Canada in 1972 is shown in Figure 2. Canadian markets east of the Ottawa Vally consumed 821,000 barrels per day of crude oil and products in 1972, all of which were imported.

With Alberta conventional crude oil production approaching capacity and with prospective reserves in the Mackenzie Delta the Arctic Islands and the offshore east coast not yet at the "threshold" volume required to support necessary pipe line systems to deliver crude to markets - or reserves not yet found in commercial quantities - the timing and quantities of synthetic crude oil that will be forthcoming from the Alberta oil sands are gaining increased significance, keeping in mind that Canadian oil requirements are increasing at about 5 percent per year.

The Magnitude and Timing of Further Oil Sands Growth

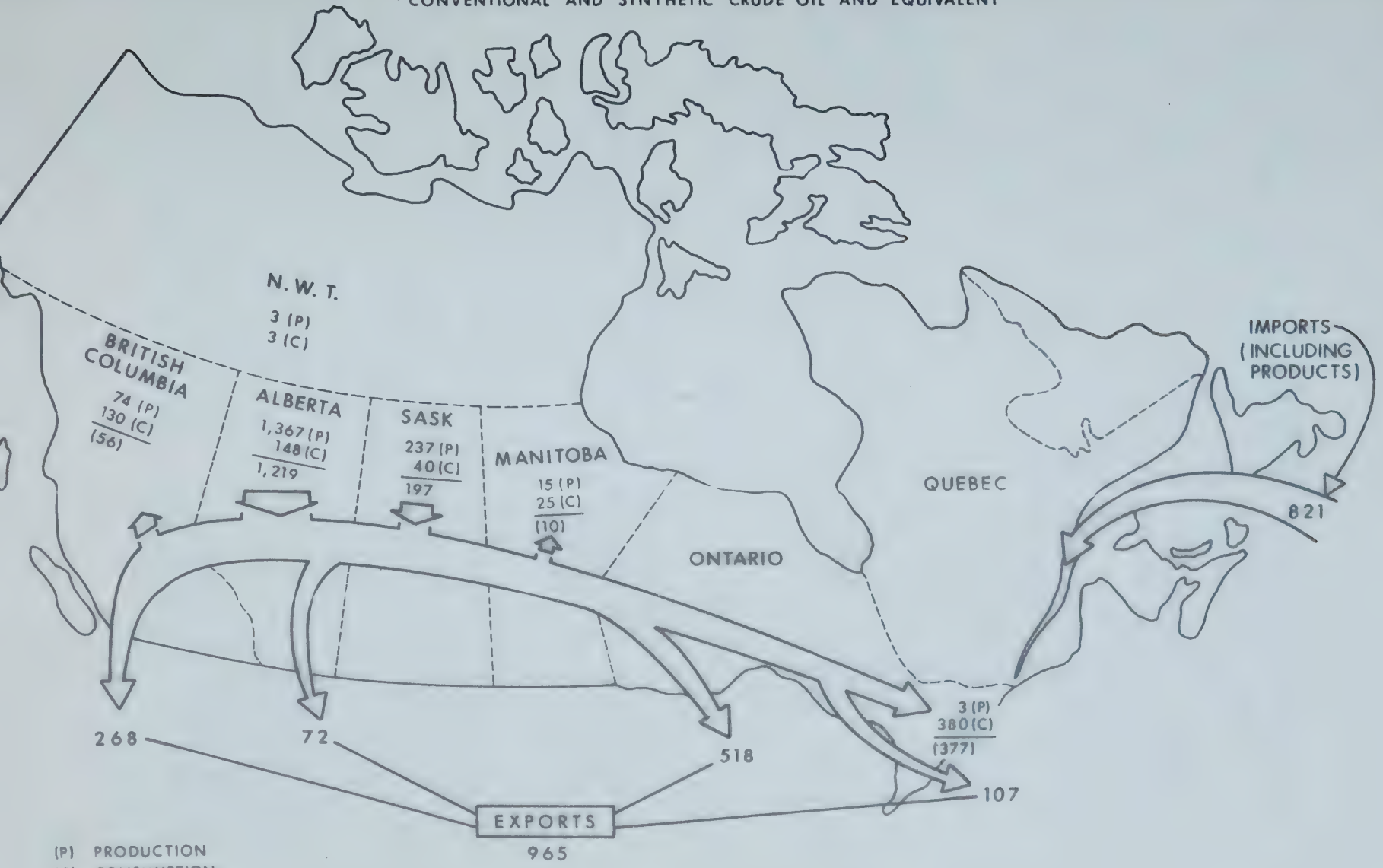
As indicated earlier, the 26.5 billion barrels of proved remaining reserves of synthetic crude oil presently recoverable from oil sands deposits that can be mined by open pit techniques are very significant in Alberta's total energy supply situation. Alberta not only accounts for about 90 percent of Canada's total remaining proved liquid hydrocarbons, about 80 percent of its remaining proved marketable natural gas reserves, but also 46 percent of its coal reserves. The following tabulation, prepared from Alberta Energy Resources Conservation Board data, shows the relative significance of the oil sands to conventional crude oil and natural gas in the province (when expressed in billions of barrels of oil equivalent):

Type of Energy Resources	Remaining Recoverable Reserves	
	Ultimate	Proved
	(billions of barrels equivalent)	
Synthetic crude oil (from oil sands)	250	26.5
Conventional crude oil	16	7
Pentanes plus	1.54	0.82
Butanes plus	0.58	0.31
Propane	0.81	0.43
Natural gas	15	8.3
Coal	230	32
Thermal content hydro electric energy*	1.1	0.45
Fossil fuel requirement to general hydro electric energy*	3.3	1.34

* over 30 year period Source: Alberta Energy Resources Conservation Board

MOVEMENTS OF OIL* WITHIN, TO, AND FROM CANADA, 1972
(THOUSANDS OF BARRELS PER DAY)

*CONVENTIONAL AND SYNTHETIC CRUDE OIL AND EQUIVALENT



(P) PRODUCTION
(C) CONSUMPTION

SOURCE: BASED ON ALBERTA ENERGY RESOURCES CONSERVATION BOARD DATA

The relative importance of the four major energy resources in Alberta, namely crude oil, natural gas, coal and synthetic oil reserves are shown graphically in Figure 3.

The 26.5 billion proved remaining reserves (recoverable from open-pit oil sands mining ignoring for the moment the 250 billion barrels ultimately recoverable mainly from 'in situ' processes) are significant when compared with other conventional crude oil reserves around the world:

Region	Billions of barrels
North America	57.4
Caribbean and South America	32.6
Western Europe	12.0
Middle East	360.0
Far East Australasia	15.5
Africa	105.0
Soviet Bloc and China	100.0
Total	682.5

Source: Canadian Petroleum Association 1972 Statistical Year Book

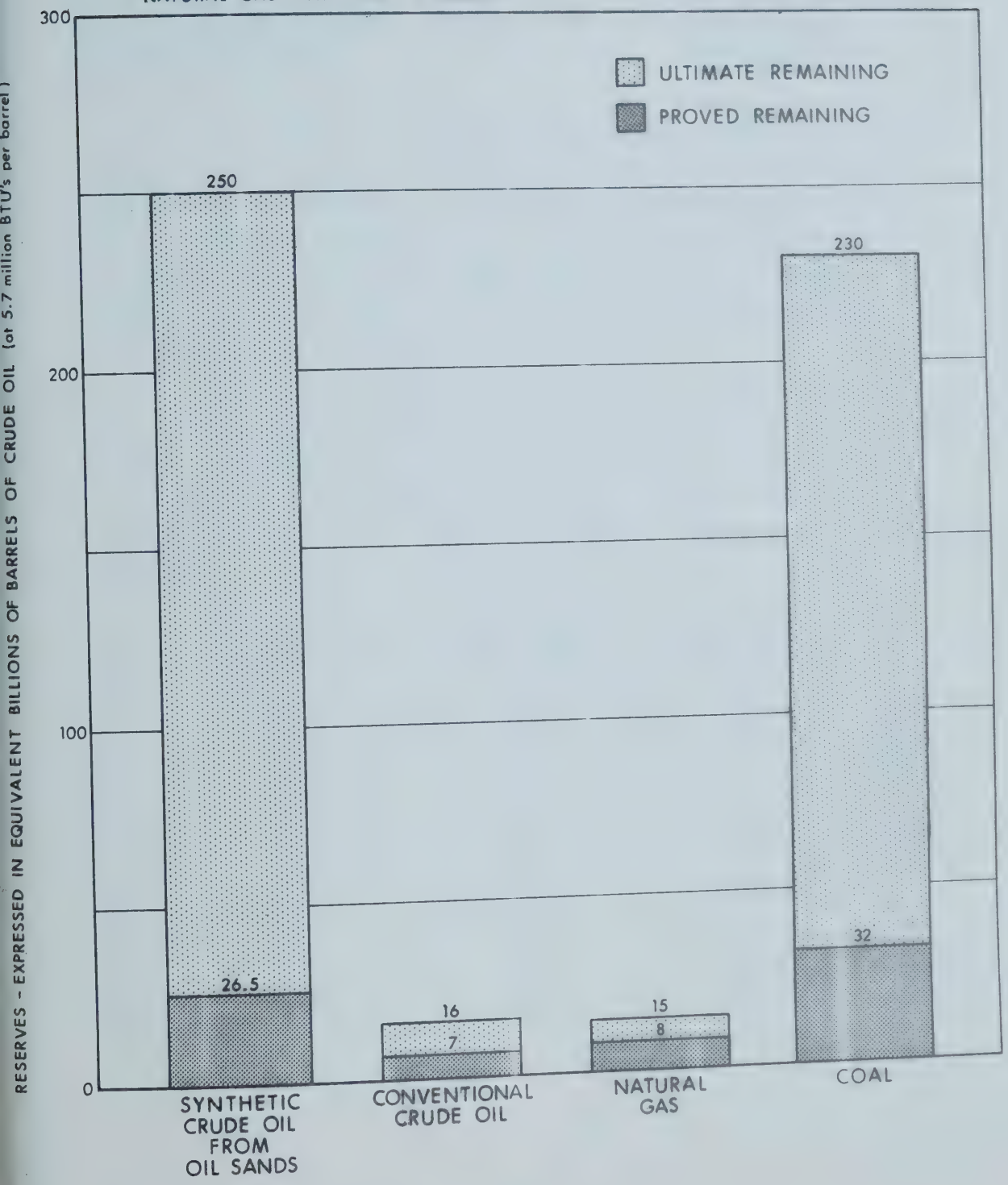
The great significance of these presently proved oil sands reserves are indicated by the fact that they alone would provide Canada's total current annual needs for crude oil for 45 years, or total needs for 25 years assuming it grows at an annual rate of 5 percent per year.

The Alberta Energy Resources Conservation Board has estimated that the presently proved recoverable reserves of 26.5 billion barrels are adequate to support 20 to 30 plants of 100,000 to 150,000 barrels per day synthetic crude oil capacity each. Each plant would probably cost in the order of $800 million to $1000 million (in 1974 terms). According to the Alberta Board, factors which will limit the number of plants actually constructed include availability of capital, equipment manufacturing facilities, design and other professional services, construction labour and operating personnel. The magnitude of these factors has been

FIGURE 3

COMPARISON OF: (1) ULTIMATE REMAINING RECOVERABLE RESERVES
(2) PROVED REMAINING RECOVERABLE RESERVES

FOR SYNTHETIC CRUDE OIL (FROM OIL SANDS), CONVENTIONAL CRUDE OIL, NATURAL GAS AND COAL IN ALBERTA



SOURCE: BASED ON ALBERTA ENERGY RESOURCES CONSERVATION BOARD DATA

estimated by the Alberta Board to be as follows, for a 100,000 barrel per day plant:

Total capital	800 million dollars
Specialized equipment	200 million dollars
Design and professional services	800 man-years
Construction labour	5000 man-years
Operating personnel	1500 men

The ERCB has also estimated that a lead time of 5 to 6 years from project conception to start of production is required and that because of these various limiting factors synthetic crude oil production will not exceed 200,000 barrels per day in 1980 and could reach 800,000 barrels per day in 1985 including four open-pit mining operations and possibly two 'in situ' operations commencing in the 1980's.

The Alberta Board projects that Alberta conventional crude oil production should peak at 1.9 million barrels per day in 1977 and subsequently decline. Increasing sythetic crude oil production should slow the decline through 1982 and after 1982 should reverse the decline as shown below based on Alberta Board data:

Year	Conventional Crude Oil	Natural Gas Liquids	Synthetic Crude Oil	Total
1972	1150	320	50	1520
1973	1420	350	50	1820
1974	1500	370	50	1920
1975	1690	315	55	2060
1976	1780	345	65	2190
1977	1890	370	80	2340
1978	1890	370	140	2400
1979	1890	370	180	2440
1980	1660	370	220	2250
1981	1525	370	220	2115
1982	1430	370	250	2050
1983	1330	370	500	2200
1984	1230	370	650	2250
1985	1160	370	820	2350

SECTION IX

SUMMARY

1. The Alberta oil sands deposits, which represent one of the largest single sources of oil in the world, are estimated to contain sufficient ultimate recoverable crude bitumen to yield 250 billion barrels of synthetic crude oil. Of this total approximately 26.5 billion barrels of synthetic crude oil is considered to be recoverable at the present time using commercially and technically feasible open-pit mining and recovery techniques. These estimates compare with remaining recoverable reserves of conventional crude oil in Alberta, which accounts for 80 percent of Canada's reserves, of 7 billion barrels at the end of 1973.

2. The presently proved recoverable reserves of 26.5 billion barrels of synthetic crude oil are sufficient to provide Canada's total needs for crude oil for 25 years even allowing for a 5 percent per year growth in annual demand. These reserves are considered adequate to support 20 to 30 oil sands developments, each with a capacity to produce 100,000 to 150,000 barrels per day of synthetic crude oil. The Alberta Energy Resources Conservation Board has estimated that synthetic crude oil production will approximate 200,000 barrels per day in 1980 and 800,000 barrels per day in 1985 and will consist of four open-pit mining operations and possibly two 'in situ' operations. In 1979, Alberta liquid hydrocarbon production is expected to peak, declining through 1982 (as a result of declining conventional crude oil production) at which time increased synthetic crude oil production is expected to reverse the declining trend.

3. Great Canadian Oil Sands is the only company presently involved in commercial production of synthetic crude oil. It

has been in production since 1967, but owing to major technical problems experienced to date, primarily as a result of the pioneering nature of its operation, the company has incurred accumulated deficits of nearly $90 million to date and has stated it will require oil prices of $8.50 per barrel to provide the opportunity to earn a satisfactory rate of return.

Syncrude Canada Ltd. expects to commence operation of its 125,000 barrel per day capacity plant in 1977 followed by the Shell Canada $700 million 100,000 barrel per day operation about 1980.

4. The Province of Alberta will be a joint venture participant in the Syncrude project, and in return for its interest in the leases and leased substances is to receive 50 percent of the pre-tax profits remaining after deduction of defined allowable deductions. The Province has a right to terminate the joint venture and then take a royalty equal to 7½ percent of total annual production of the leased substances.

5. Albertans and other Canadians, through Alberta Energy Company Ltd., will have the opportunity to participate further in other aspects of the Syncrude project, including an 80 percent interest in the 272 mile pipeline constructed to move synthetic crude oil from Fort McMurray to Edmonton, a 50 percent interest in the $100 million Syncrude power plant, plus an option to acquire up to a 20 percent interest in the Syncrude plant itself. This latter option is exercisable at any time up to the commencement of production at which time design and construction costs, crude oil prices and other important relevant factors should be more clearly defined.

(Alberta Energy Company Ltd. was recently formed with a capitalization of $500 million to provide Albertans and other Canadians with an opportunity to participate in development of Alberta's resources. In order to assure that Albertans will enjoy effective control of the company, the Government will own 50 percent of the shares in the Company.

Alberta Energy Company Ltd. will also be a principal shareholder in Pan-Alberta Gas Ltd. and in conjunction with industry, in development of the sizeable Suffield Block gas reserves.)

6. As a result of Alberta's joint venture participation in Syncrude, plus the equity position in the pipeline, power plant and option to participate in the Syncrude plant itself, the citizens of Alberta, through its provincial government, directly or indirectly will realize 60 percent of total profits, the remaining 40 percent going to the consortium of four companies which has assumed all the risk.

7. It is the Government of Alberta's present view that development of the oil sands represents the most promising potential on a project basis for new jobs for Canadians. If one oil sands plant is constructed annually during the 1980-2000 period, an average work force of 5,000 will be required for that full period. Assuming 1,500 permanent employees per oil sands plant, direct operating labour force of oil sands plants would increase annually to a level of 30,000 by the year 2,000. By that year, oil sands activities alone could support a direct and indirect work force of 180,000 persons and additional population in the province of 450,000 people. The rapidly increasing need for employees of oil sands developments may create severe problems of labour supply, particularly since a large percentage of both construction and operating personnel will be highly skilled.

8. There is a need for accelerated research, particularly regarding the adaptation of 'in situ' thermal recovery technology to the unique problems associated with oil sands developments. Further large scale recovery and upgrading of crude bitumen, whether by open-pit mining or 'in situ' methods could have an adverse impact on the environment in the area, unless preventative measures are implemented. The Government of Alberta

has commissioned and has obtained detailed studies dealing with environmental aspects of such developments. Considerable research into a variety of environmental aspects will be required as the basis for establishment of appropriate preventative measures.

The research required to resolve the technological, environmental and social problems associated with successful development on a large scale of the oil sands potential in Alberta will require expenditures of many millions of dollars by potential developers, other organizations and government agencies at various levels. There is some urgency to accelerate these research activities in order that useful results will be available in advance of large scale developments. The long term benefits to Canada would be maximized if this research is undertaken in Canada by Canadians to the fullest extent possible.

In this regard the Government of Alberta has announced the creation of the Alberta Oil Sands Technology and Research Authority, the initial step in "Energy Breakthrough", a Government of Alberta Project with important responsibilities to achieve, as rapidly as possible, a breakthrough in technology and research that is essential if the recovery of crude bitumen from Alberta's deep-seated oil sands is to be achieved.

Creation of the Authority, plus additional steps in "Energy Breakthrough" represents a major development in the Government's responsibility to manage the energy resources owned by Albertans, and to make the oil sands an accepted, reliable and proven part of the Canadian and world energy supply.

The Government has committed a $100 million dollar fund to the Authority to be available for technology and research over the next five years. Through the efforts of the Authority the knowledge to harness the full Alberta oil sands potential can be accumulated and coordinated. The

Authority will have the responsibility to establish a fair and equitable procedure for accumulating and pooling existing and future technological developments in this field. Private industry, particularly existing lessees, will be encouraged to expand their research efforts in cooperative programs between industry and the Authority.

The Government recognizes the significant contribution by industry (in terms of effort and expenditures) to research on oil sands technology. Arrangements will be made with industry to protect the ownership interest and competitive position of individual companies' substantial investments in research undertaken to date. The Authority may enter into arrangements with other interested governments to develop a coordinated approach to oil sands research, to avoid duplication of research efforts, and to establish priorities that will meet the Alberta and other Canadian public interest.

9. During the first half of 1974, in addition to launching the Alberta Oil Sands Technology and Research Authority, the Alberta Government will be announcing various organizational structures to provide the provincial government's services to the citizens working in the oil sands' areas as a result of the rapid expansion in this part of the province. In addition, the Alberta government intends to announce a longer term oil sands' development policy establishing terms of reference for future plants which will include the degree of Alberta and Canadian participation required; the nature of the royalty arrangements; and environmental restrictions. This policy statement will also set forth a tentative schedule for the pace of future plant development.

10. In conclusion, it appears clear that the long-term self-sufficiency of Canada in terms of crude oil requirements depends upon orderly and accelerated development of Alberta Oil Sands.

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